TABLE 5. SOLID RADIOACTIVE WASTE DISPOSED OF OR STORED AT THE RWMC FROM 1952 THROUGH 1983

Calendar Year	Buried LLW Volume (m^3)	Buried LLW (Ci)[a]	Buried TRU Volume (m^3)	Buried TRU (Ci)[a]	Stored Tru Volume (m^3)	Stored Tru (Ci)[a]
1952-60	18 475[b]	60 920	10 545	11 300	--	--
1961	6 091[b]	155 650	2 439	3 650	--	--
1962	5 730[b]	115 320	2 755	3 780	--	--
1963	5 445[b]	251 480	3 357	10 520	--	--
1964	3 132	146 330	3 764	12 270	--	--
1965	4 076	685 890	3 454	17 010	--	--
1966	4 634	859 010	4 859	65 290	--	--
1967	3 820	836 130	5 826	41 670	--	--
1968	3 947	268 810	9 791	32 690	--	--
1969	4 740	935 520	6 770	35 480	--	--
1970	4 151	482 640	8 429[c]	15 460	1 420	4 225
1971 64,241 m³	4 026	350 900	--	--	7 149	13 920
1972 (=88,600 yd³)	3 548	214 700	--	--	5 955	27 690
1973	3 880	339 900	--	--	5 811	24 580
1974	3 694	18 320	--	--	4 126[d]	23 650
1975	5 692	13 180	--	--	3 895[e]	32 580
1976	6 212	218 800	--	--	1 103	11 075
1977	6 591	824 100	--	--	4 597[f]	37 147
1978	5 932	1 119 000	--	--	2 761[g]	40 142
1979	5 348	243 700	--	--	3 302[h]	23 892
1980	5 070	149 500			2 254	17 825
1981	3 064	130 800	--	--	2 714	26 253
1982	3 185	512 000	--	--	2 859	26 820
1983	5 474	54 760	--	--	3 035	25 993
1984	3 906	144 100	--	--	4 068	35,308
Totals	129 503	9 131 460	61 989	249 120	55 049	371 100

=80,600 yd³

a. Radioactivity at time of disposal or storage, without accounting for subsequent decay.

b. Includes 7014 m^3 of offsite-generated waste received during the period that the RWMC was designated an Interim Burial Ground, 1960 through 1963.

TABLE 5. (continued)

c. These data do not reflect the retrieval of 4830 m^3 of Rocky Flats waste from the SDA.

d. Includes 89.5 m^3 of previously buried waste retrieved in the IDR project.

e. Includes 505.3 m^3 of previously buried waste retrieved in the IDR project.

f. Includes 2006 m^3 of previously buried waste retrieved in the IDR and EWR projects.

g. Includes 1785 m^3 of previously buried waste retrieved in the IDR and EWR projects.

h. Includes 9 m^3 of previously buried waste retrieved in the IDR and EWR projects.

NOTE: Details may not add up to totals because of rounding.

Since 1970, substantial study and effort have been devoted to reducing waste volume. In 1970, the General Manager of the AEC assigned a study group to investigate compaction. A June 1970, report estimated that half of the AEC waste could be compacted and recommended funding, installing, and evaluation of demonstration units.[36] In 1971, the Naval Reactors Facility (NRF) started using a mechanical compactor to reduce the volume of NRF waste prior to shipment to the RWMC.[86]

Waste Management investigated the NRF compaction system and selected a compactor based on the design criteria developed in the Naval Reactor Program.[86] By April 23, 1973, the NRTS compactor had arrived to await completion of the building to house it. As shown in Figure 20, the compactor is a conventional vertical-downstroke, hyraulically operated, 45.4 metric ton baler, with HEPA filters added to control contamination. It was installed in the Waste Volume Reduction Facility (WVRF), the west bay of WMF-601 built in 1974. The filtered exhaust of the compactor was re-routed in June 1984 to discharge outside the WVRF Building. This modification was made to protect the operator from potentially hazardous fumes or vapors resulting from the inadvertent inclusion of prohibited materials in the compactible waste.

Since January 1974, compactible waste received from INEL waste generators (other than NRF) has been compacted.[87] The nominal volume reduction achieved at the RWMC as 10:1.[14] Routine beta-gamma compactible waste is separated at the point of origin; the waste is compacted into 272.2-kg bales at the WVRF and placed into pits. Since 1974, most onsite non-TRU compactible waste has been transported to the RWMC in plastic bags to accommodate the new compaction system.

5.4.3.2 Disposal Practices. Implementation of space-saving measures extends to present-day disposal practices. Records of all the buried waste show the distance (in feet) of the waste from a presurveyed reference point. Within the 88-acre SDA, pits, trenches, and soil vaults have been used for permanent disposal of radioactive waste.

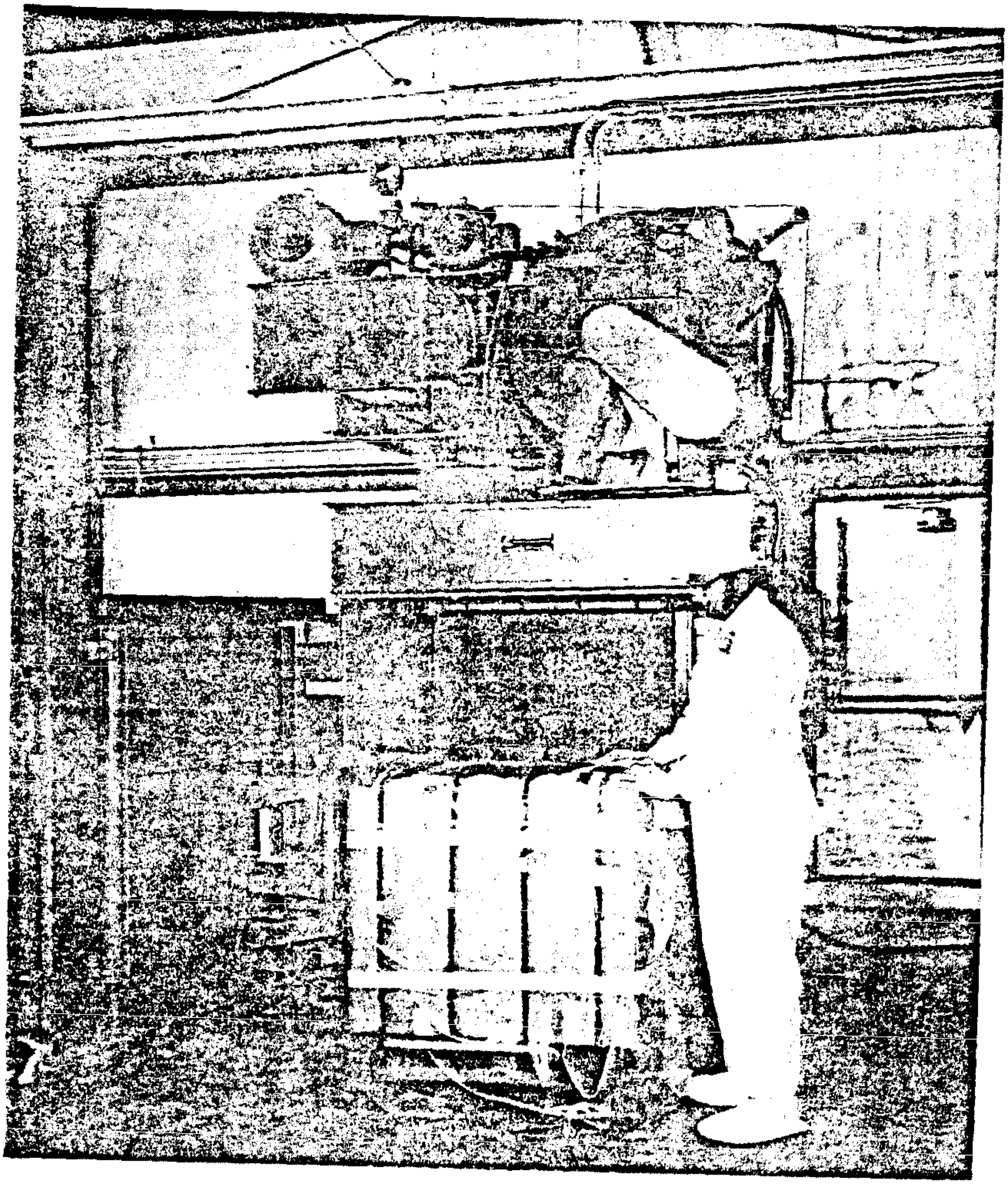

Figure 20. NRTS 45.4- metric ton baler.

Pits--The pits are used for routine, solid, low-level, beta-gamma-contaminated waste with dose rates below 500 mR/h at 0.9 m. Figure 21 is a photograph of current pit disposal. Excavated in a previously surveyed area with scraper-carryall and bulldozers, pits average 5 m deep by 30.2 m wide and vary in length. Pit 17 was excavated to a depth of approximately 9.1 m after explosive fracturing of the basalt. As a means of making maximum use of the SDA, pits are excavated into the basalt, the exposed basalt then is covered with 0.6 m of soil. In FY-1985 Geotextile Fabric was incorporated in the upper portion of this soil cover to add stability for the waste stack. After the flooding in February 1982, the earth berm around Pit 17 was modified to eliminate the 0.3-m-high vehicle access. The continuous berm is 0.6 to 1.5 m above grade. The earth berms serve as radiation shielding, firebreaks, and dikes.

A crane pad was constructed for the bulk disposal area in FY-1985.

Soil Vaults--Beginning in 1977, areas not suited for pits were set aside for drilling of soil vaults. This practice not only helped to conserve SDA space, but also reduced personnel exposure to radiation.[84] High-radiation (greater than 500 mR/h) beta-gamma waste is deposited in the soil vaults. Rows of these vaults are drilled along predetermined centerlines, each vault separated from previously buried waste by approximately 0.6 m (Figure 21a). Soil vault diameters vary from 0.4 to 2 m; minimum depth is 2 m. If the drilling has penetrated basalt, 0.6 m of soil is placed on the vault floor. Open soil vaults are surrounded by barriers denoting the hazard.

Trenches--The edges of trenches were dug along predetermined centerlines and were separated from adjacent centerlines by no more than 4.9 m. This allowed maximum use of available space without disturbing previously buried waste. The average width of the trenches was 3.1 m (those with collapsing walls were wider). Waste with high gamma radiation levels was handled remotely using special shielded containers and boom cranes. When the trenches were full, they were covered with a minimum of 0.9 m of soil. Locations of all trenches and soil vaults were identified by concrete monuments. A brass plate on each monument was stamped with the

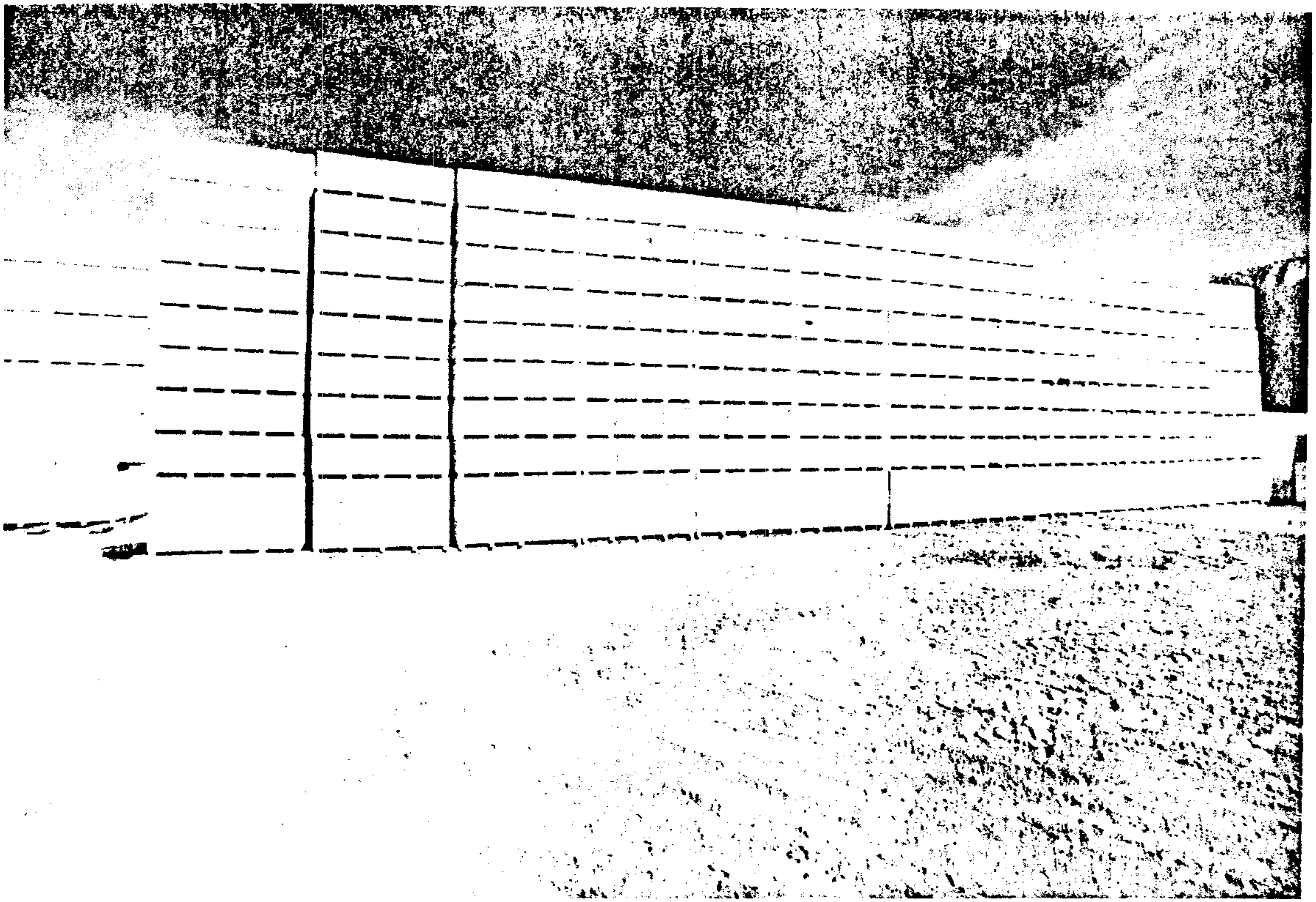

FIGURE 21. CURRENT PIT DISPOSAL

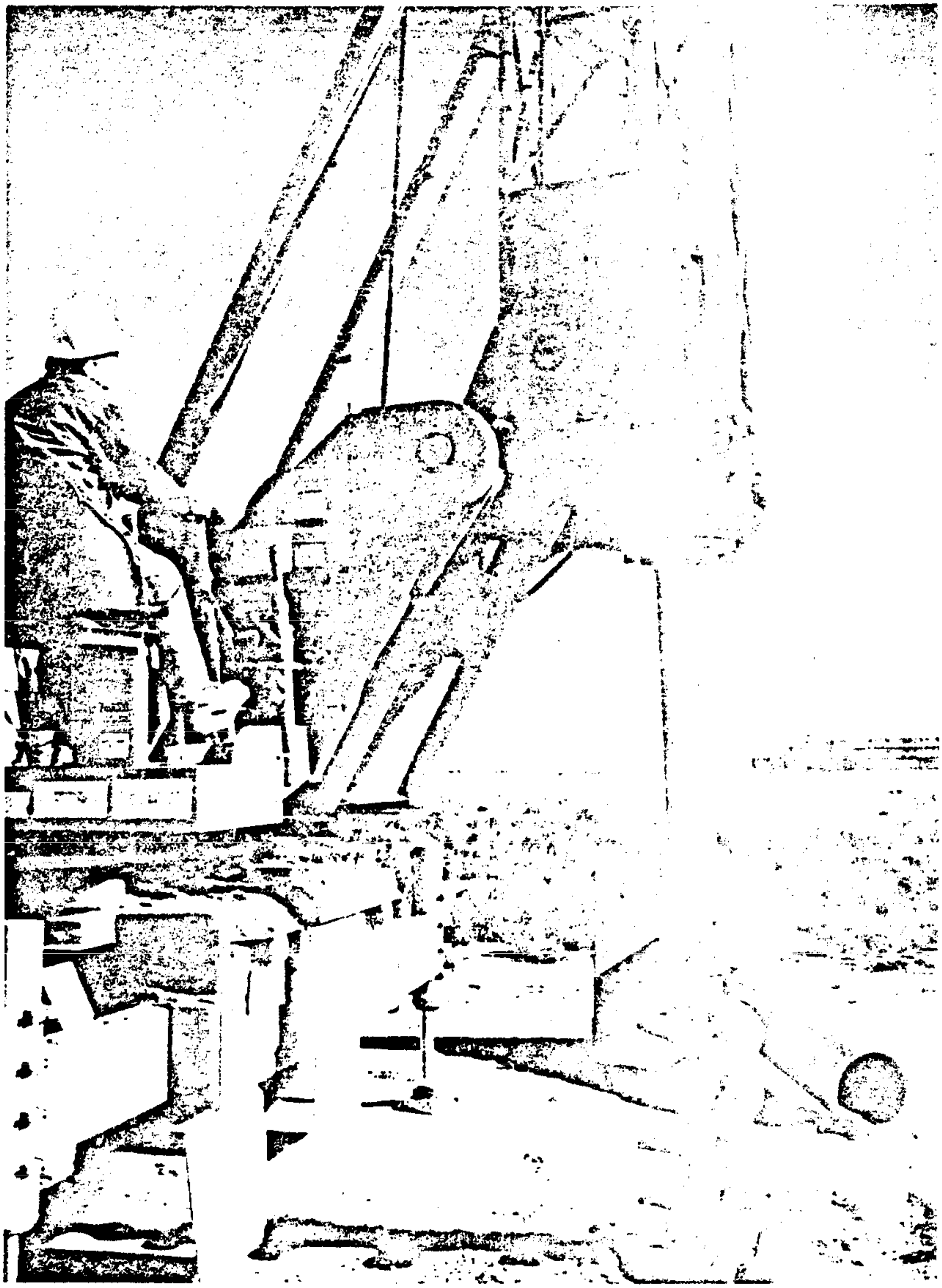

Figure 21a. Digging 45.7 cm soil vault and soil vault liner.

opening and closing dates. All non-TRU waste packages exceeding 500 mR/h at 0.9 m were deposited in trenches, except for those placed in soil vaults.

In July 1981, trench disposals were discontinued, and the unfilled trench area was redesignated for soil vault disposals.

Disposal Operations--Waste is transported to the SDA on flatbed trucks and trailers, some in shielded casks. The disposal location of all waste is recorded on "Disposed Solid Radioactive Waste Form," ID F 5480.2A, which accompanies the waste shipment.

Waste compacted into 0.4-m^3 bales in the WVRF is placed in pits. Most of the noncompactible waste received for disposal in the SDA is contained in 1.1 by 1.1 by 2.4-m wooden boxes coated with fire-retardant paint. These boxes are stacked in pits in a close-packed array with minimum space between waste packages to conserve space. Large bulky items, such as support stands and tanks, are wrapped in 0.15-mm or heavier polyethylene plastic and are also placed in pits. Baled waste, boxed waste, and large bulky items are placed in separate areas of the pit.

The close-packed array stacking, made possible with the issuance of the packaging criteria in 1978,[69] has increased pit space being utilized from 30% to about 75%. Further development of size reduction techniques currently under development (smelter, incinerator, metal compactor, etc.) will allow even more waste to be placed in the close-packed array.

Waste packages are covered with soil to isolate them from the environment and to reduce radiation levels to less than 1 mR/h at 0.9 m from the surface (at least 0.9 m of soil is required). The soil cover is crowned and compacted to allow efficient natural drainage.

5.4.3.3 Increasing Usable Disposal Space. A study[82] completed in FY 1980 predicted the useful lifetime of the SDA for disposal based on current waste projections and handling techniques, and the known available space remaining at the SDA. The study concluded that the available SDA space could be depleted as early as 1996. The study also concluded that major excavations of basalt could extend the SDA lifetime significantly. A more recent study[85a] indicated that the life expectancy of the SDA could be extended to the year 2090, if the explosive rock fracturing is continued. A bulldozer with a rockripper (added to the RWMC heavy equipment inventory in FY 1979) is used for removing fractured basalt in SDA pit areas to increase usable disposal volume. This machine is shown operating in Pit 16 in Figure 22. Other methods of fracturing rock are being evaluated. A hydraulic impact hammer was procured in FY 1979 to aid in fracturing rock that the dozer-ripper could not remove. Although effective, this method is economically unacceptable.

Testing of explosive fracturing of basalt began in FY 1980--including a scale-model test outside the RWMC and explosive tests in Pit 17. The test series in Pit 17 consisted of single-hole charges with 453.6 to 4535.9 g of explosive. A scaled pattern, similar to proposed production-scale array, was tested to evaluate maximum seismic disturbance, fracture propagation, and aggregate displacement. The 7.6 by 7.6-m array contained about 362.9 kg of explosive; 36.3 kg were detonated at each delayed firing. The aggregate pile resulting from the array test is shown in Figure 23.

Production-scale explosive rock fracturing began in Pit 17 in FY 1981. These blasting projects fractured 2977 m^3 of basalt in FY 1981,[88] 14 211 m^3 in mid-FY 1982,[89] 22 950 m^3 in FY 1982 and FY 1983 and 24,092 m^3 in FY 1984.

Blasting is prohibited within 15.2 m of buried waste or other critical receptors, such as buried water mains. Consequently, nonexplosive methods are being investigated to fracture basalt within the buffer zone. In FY 1982, BR1-STAR (a high-expansion compound) and freezing water were tested. Freezing water was unsuccessful, and BR1-STAR was successful only when used in holes drilled in basalt that had an exposed, free face.[90]

5.4.4 Liquid Corrosive Chemical Disposal Area

The Liquid Corrosive Chemical Disposal Area (LCCDA), a pit located approximately 1 km east of the main RWMC, was used for the disposal of

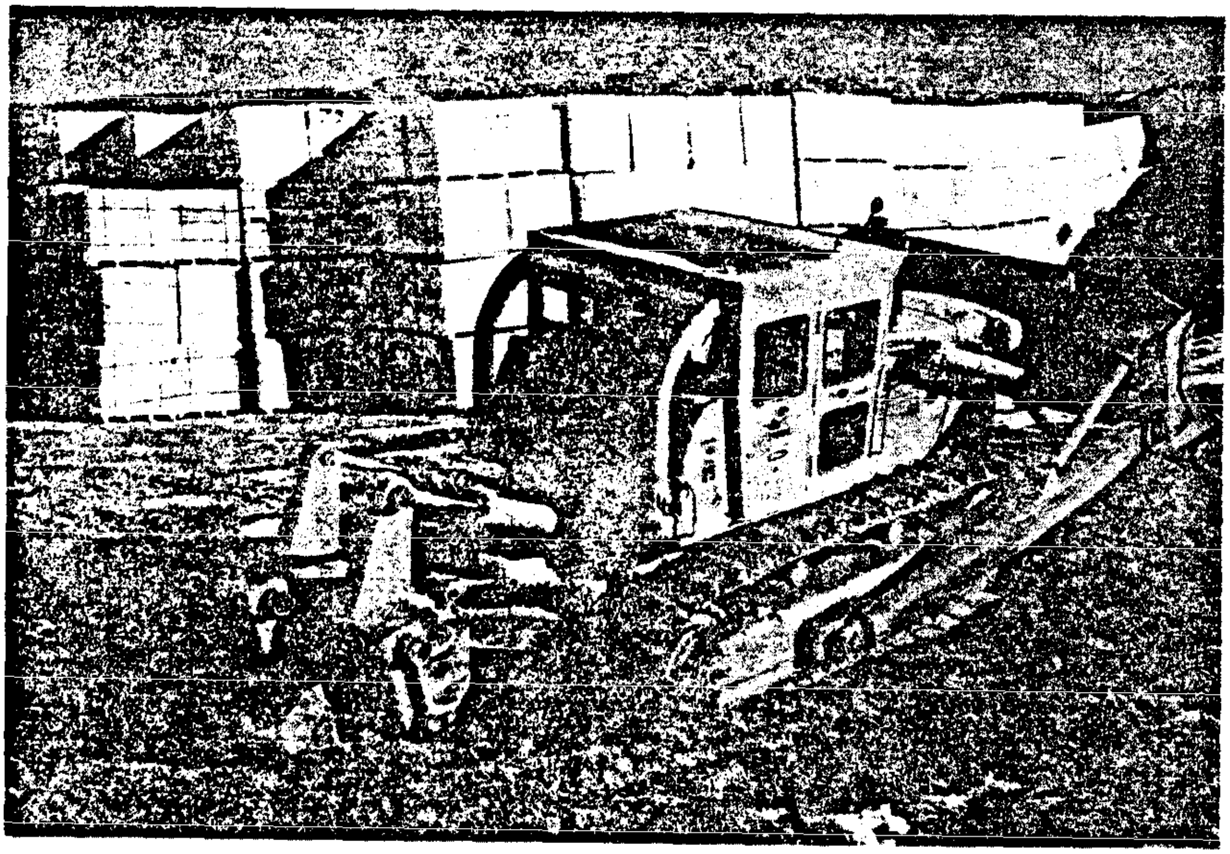

Figure 22. Rock ripper removing fractured basalt in Pit 16.

Figure 23. Aggregate pile resulting from FY 1980 explosive fracture.

small quantities of nonradioactive acid and caustic waste. Limestone material was added to the pit to neutralize the acid wastes. This pit, formerly maintained and operated by CF Maintenance, became the responsibility of the Waste Management Operations Branch (WMP-O) during FY 1979. Specific criteria for the packaging, handling, and types of material allowed for disposal were initiated by WMP-O.[91] The LCCDA was closed July 31, 1981, and was decommissioned October 31, 1981.[92]

5.4.5 Drainage

Even after improvements were made to the diking system following the 1969 spring flood, local flooding within the RWMC continued to be a concern.[76] By the fall of 1969, all holes, crevices, and cracks were routinely filled in preparation for the spring snow melt.[34] A 1970 letter noted that grading and a drainage system would probably be necessary to prevent flooding within the RWMC.[80] In FY 1972, grading was instituted to improve drainage. A topographic study of the area was also done in 1972 to determine the areas that needed to be filled. In 1976, a sump pump was installed near the perimeter fence to keep water from flowing over the trenches. In FY-1985 this drain system was enhanced with the installation of a flowmeter, automatic water sampler and two culverts. The latter provide passive flood control and were designed to meet the 100 year flood criteria.

During the last quarter of FY 1979, a controlled snow disposal area for the RWMC was installed, a 97.5 by 302-m gravel-base pad inside the TSA and northeast of TSA-2. This area drains to the northeast out of the TSA to the main RWMC drainage ditch.

Use of magnesium chloride as a dust suppressant and road surface enhancement was tried on a trial basis in 1984 and continued in 1985.

A FY 1980 paving and draining project provided discrete sumps and drainage facilities on TSA-2 at the Cell 3 location. These drains reduce moisture flow under stored waste and allow for discrete sampling of any moisture traversing Cells 2 and 3. Additional storm drains were also installed in the RWMC Facility Building Area in FY 1980.

5.4.6 Flood Control

A USGS study was performed in 1972 to determine the best method for improving flood control at the NRTS, i.e., protecting the facilities from flood waters originating outside the NRTS.[93] That study suggested doubling the capacity of the existing diversion channel into the spreading grounds as the most feasible means for improving flood control. This recommendation was later implemented in early 1983.

Numerous flood-control measures were taken following the flooding in February 1982. The drainage channel inside and outside the SDA was widened. Culverts were installed in the road between the SDA and the dry lakebed south of the SDA, and the southeastern SDA culvert was removed. A second sump pump was moved from the SDA north fence (east of the EWR site) and was installed in the SDA beside the sump pump near the east SDA fence (south of the access road). The second sump pump doubles the pumping capacity in the SDA. An additional emergency, forklift-portable sump pump was procured. Moisture-exclusion soil was placed and graded over disposed waste. In the spring of 1984 flood control Dike-1 was raised 1.8-m and Dike-2 2.4-m. Rock rip-rap was placed on both dikes.

5.4.7 Radiation Exposure Reduction

From 1971 until trench disposals were discontinued in 1981, the increased specific radiation of solid waste packages from NRF necessitated the use of a concrete shield while trenches are being filled.[4] Under early waste handling practices, a crane unloaded the high-activation-product radioactive waste from NRF into pits, and large amounts of backfill were then added to reduce surface radiation to acceptable levels. In the early 1970s, NRF waste was placed in metal baskets that were stacked inside special removable, shielded vaults in the trenches. This procedure conserved space and reduced radiation levels. In 1973, a formalized training program was developed for operators and supervisors at the RWMC. This program emphasizes the methods being implemented to perform the tasks safely and with a minimal radiation exposure to personnel. In 1974, a new trench liner and concrete cover (shown in Figure 24) were used with highly radioactive scrap waste shipments.[50]

The disposal of high-radiation beta-gamma in soil vaults has reduced personnel exposure since the practice was initiated in 1977 because:

a. Less time is required for disposal.

b. Personnel work at greater distance from the waste. Transfer is accomplished from either a bottom-discharging cask (Figure 25) or by free-air transfer from old casks.

c. More soil side shielding is provided in this mode of disposal.

In FY 1980, conceptual design and estimates were completed on a large 49.9-metric ton bottom-discharge cask for use at RWMC, NRF, ICPP, and TAN. The cask, Figure 25, provides reduced radiation exposure for operating personnel and improved space efficiency at RWMC because of the waste insert design. Specifically, the cask system eliminates the free-air transfer requirements of the NRF scrap cask. The 49.9-metric ton cask was received and placed in operation in FY 1982.

5.4.8 Fire Protection and Emergency Action Plans

After the 1966 fire, a firefighting plan evolved. In 1970, a formal Fire Protection Plan for the RWMC was implemented.[94] In 1974, a 946 250-L tank was installed to provide a water supply for firefighting.

An Emergency Action Plan was completed in 1972. In 1974, an evacuation warning system was installed at the Burial Ground,[51] and in 1977, complete RWMC standby electrical power was installed to operate evacuation sirens, lights, and a fire pump. The Emergency Action Plan is updated annually or as needed. The present procedure defines

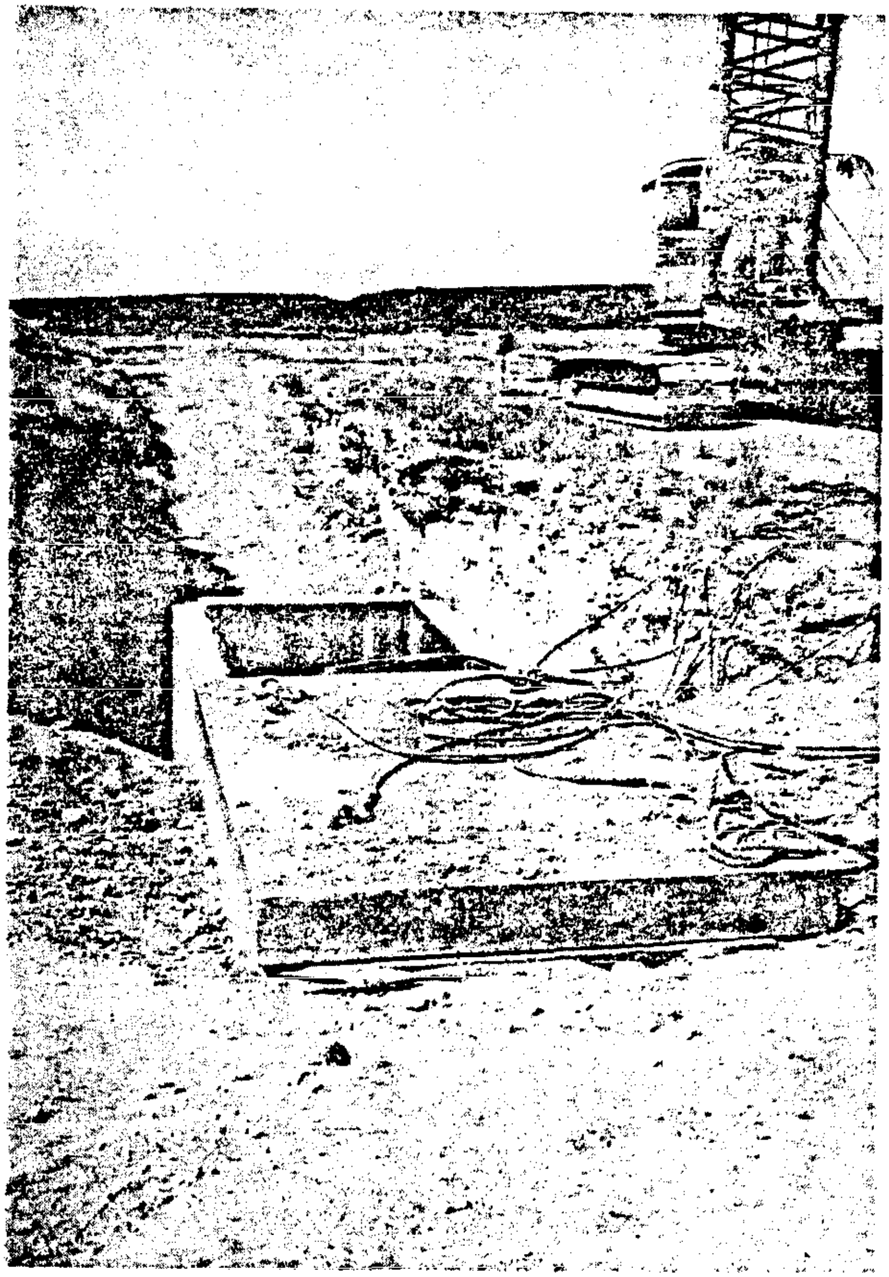

Figure 24. Concrete shield for radiation exposure.

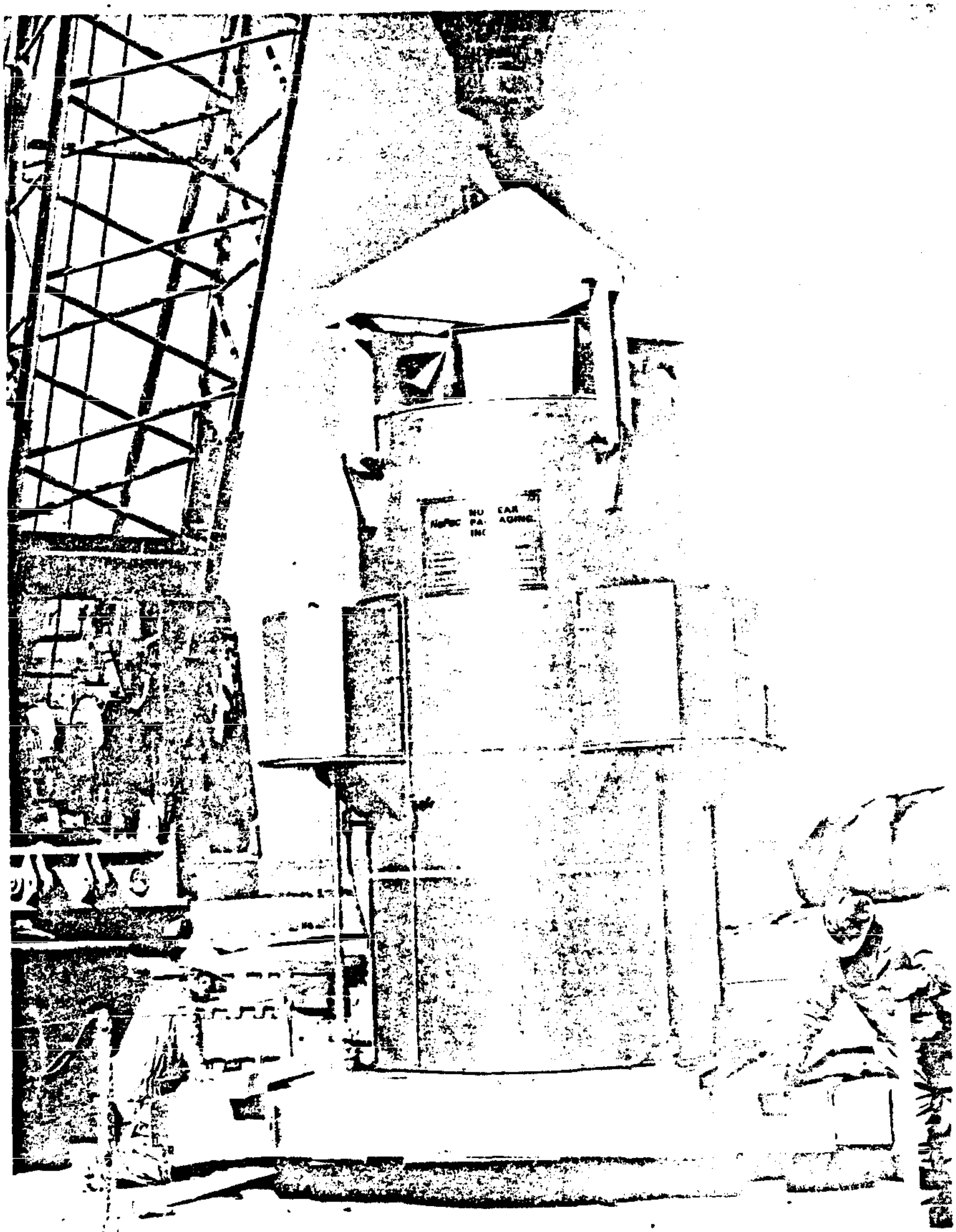

Figure 25. 49.9 metric ton bottom-discharge cask.

responsibilities of personnel and the actions required for each type of emergency--flood, tornado, earthquake, fire, bomb threat, riot, and public disturbance.

5.4.8.1 Combustion Tests of Waste Boxes. Two tests were conducted at the INEL to determine the combustion characteristics of (a) fiberglass-reinforced polyester-(FRP) coated plywood boxes used for transuranic waste storage and (b) INEL standard disposal boxes (plywood covered with fire-retardant paint). Test results indicated that if the boxes were exposed to credible ignition sources, box integrity would be maintained for a period sufficient to provide fire suppression measures, if the fire were detected promptly.[95,96] Because of the test results, fire detection equipment will be added to waste handling locations in the TSA and SDA.

Testing of fire-retardant paint continued in FY 1981 (Figure 26). Plywood surfaces were painted with fire-retardant exterior paint. On both newly painted samples and those that had weathered for 218 days, the paint foamed evenly and protected the plywood when flame was applied.[97,98]

5.4.8.2 Fire-Suppression Upgrade. Major improvements to fire suppression capabilities were begun in FY 1980. Dry pipe fire mains were installed in the SDA, and new sprinkler systems were installed in WMF-602 and -609. Old fire pumps in WMF-603 were removed in preparation for installation of the new pumps.

Ultraviolet fire detectors were installed in ASWS-2 and around Pit 17 FY 1981 and 1982. The detectors in ASWS-2 are operational, but those around Pit 17 were removed due to unsatisfactory performance. In addition, a dry-pipe fire main and two hose reels were installed along the north anchor blocks in ASWS-2.

5.4.9 Environmental Surveillance Since 1970

Since 1970, greater emphasis has been placed on environmental surveillance investigations. The following chronology highlights some events and studies.

Figure 26. Flame testing of fire-retardant paint.

5.4.9.1 Radionuclide Migration. Investigations into possible radionuclide migration have continued since 1971.

Shallow Well Sampling--In 1971, the USGS drilled six shallow wells within the SDA, and took sedimentary samples from each.[3] Four deeper wells were drilled outside the SDA. Trace amounts of radioactivity were found in about one-half of 44 samples from the six holes and from one hole tapping a zone of perched water.[99] In most instances, the levels of radioactivity detected were below those found in surface soil of this same region resulting from atmospheric weapons testing fallout. Results of these investigations were inconclusive, because it was suspected that insufficient control during drilling and handling contributed to the sample contamination. Statistical error also may have produced some of the positive determinations.

In 1975, ERDA conducted a core drilling study using improved coring and anticontamination procedures. Analyses of the samples showed no detectable quantities of waste radionuclides, and this study suggested that artificial contamination of samples probably was a factor in the USGS study.[100] Five of the six shallow holes were filled with concrete after subsurface core samples were taken.

In an investigation conducted in 1976 and 1977, samples were obtained from wells drilled adjacent to the waste, as in previous investigations. Samples also were collected from undisturbed soil directly beneath buried waste. Analyses of samples obtained from immediately beneath the waste showed limited waste radionuclides were well contained. Trace amounts were obtained in a few well samples to depths of about 70.1 m. In order to confirm these positive results, samples were analyzed again where enough material was available. The second analysis failed to confirm the presence of the trace quantities of waste radionuclides. The positive levels first indicated were far less than background levels found in surface soils, and accurate laboratory analysis for these extremely low levels is very difficult.[99]

In 1978, another study was performed to identify and characterize radionuclide migration in soils and substrata of the RWMC. A complete set of new samples was obtained from core material collected in the 1976 and 1977 core drilling program. This investigation indicated that there is no conclusive evidence that radionuclides originating from the buried waste have migrated to the underlying Snake River Plain aquifer. Furthermore, the concentration and location of waste radionuclides detected in subsurface samples are not great enough to indicate that the buried waste constitutes a hazard to the aquifer under present climatic conditions. The study concluded that most positive results observed in core samples from all studies since 1975 were probably a result of statistical variation rather than evidence of radionuclide migration.[101]

In the summer of 1979, three wells were drilled in and around the RWMC. Two wells were drilled in the eastern half of SDA (one adjacent to the TDA and one in the extreme southeast corner of the SDA); another was drilled east of the TSA (outside the fence). Two wells were drilled through the 73.2-m sedimentary interbed; the third was abandoned at approximately 61.3 m, because of drilling difficulties. Core samples above, within, and beneath the 33.5 and 73.2-m sedimentary interbeds were collected. Liquots from each core sample were radiochemically analyzed for the presence of waste nuclides from the RWMC.[114]

During June and July 1985 seventeen shallow holes were drilled through the surficial sediments to the basalt. Each hole was sampled continuously from the surface to the basalt. Each hole was instrumented with various combinations of suction lysimeters, psychrometers, tensiometers, and gypsum blocks. The holes were backfilled and provided with 8 x 24 inch surface casings and caps. Radioanalysis of the samples collected will be performed in late FY-1985.

<u>Subsurface Water Sampling</u>--The deep wells, plus the RWMC production well (drilled in 1974) became the basis of the subsurface water (aquifer) sampling program. The USGS formulated and conducted the initial sampling program during 1971 and 1972 and conducted subsequent sampling and analysis semiannually.[102]

A study by ERDA and USGS was initiated in 1975 to determine if reproducible results on either detectable or nondetectable quantities of americium or plutonium could be obtained from water samples collected from the aquifer. Analyses of water samples from the RWMC production well showed no plutonium or americium concentrations distinguishable from the background.[103]

Subsurface Soil Water Monitoring--In 1973, a Burial Ground surface soil water monitoring plan was established, 26 shallow holes were drilled to the first basalt underlying the surface soil, and perforated pipes were installed in the RWMC. These pipes are capped on the upper end. Seven similar holes were installed in the SL-1 Burial Ground. Monitoring of these holes became a part of the surveillance plan. The USGS takes samples from these holes in late fall and early spring.

5.4.9.2 Sampling Grid. During the summer of 1972, a sampling grid was established near the Burial Ground. This grid was used for collecting small mammals and soil samples near the RWMC in 1972 and 1973. Analyses of the animals and soil samples led to the conclusion that storing radioactive waste at the RWMC had little effect on the concentrations of activation and fission products in the environment near the RWMC.[104] However, trace amounts of transuranic nuclide concentrations slightly above background could be detected 2.9 km from the SDA perimeter.[105]

5.4.9.3 Environmental Surveillance Plan. In 1973, when the environmental monitoring program for RWMC was expanded to include geologic and deep subsurface hydrologic studies, a draft environmental surveillance plan made eight efforts routine:[106]

a. Surface radiation survey

b. TLD perimeter survey

c. Soil sampling

d. Air sampling

e. Surface water sampling

f. Subsurface moisture probing

g. Subsurface water sampling

h. Periodic visual inspections.

A revised plan was issued in March 1977.[102] In May of that year, five additional TLD locations were established around the perimeter of the TSA.[107] In 1979, a project plan for environmental monitoring was issued for the first time.[108]

During FY 1980, the Environmental Monitoring Program at RWMC published a detailed project plan[109] and the RWMC Environmental Handbook.[110] Purposes of the project plan are:

a. To define which environmental surveillance activities are basic to the monitoring programs

b. To detail the experimental design for each activity

c. To identify and schedule special investigative studies that will establish a complete environmental data base for RWMC and surrounding environs

d. To accommodate potential changes in operations at the RWMC, e.g., possible retrieval of stored and buried TRU-contaminated waste, and construction of the Transuranic Waste Treatment Facility (TWTF)

e. To detail the entire environmental monitoring program at RWMC for FY 1981 and succeeding years.

The RWMC Environmental Handbook[110] is the detailed procedures manual for implementing those environmental monitoring activities identified in the Project Plan for Environmental Monitoring at RWMC.[109] In addition, the handbook includes a synopsis of rules and regulations governing environmental monitoring programs for radioactive disposal sites, and brief reviews of major environmental legislation. Table 6 summarizes the current environmental monitoring at the RWMC. Figure 27 shows locations of air-monitoring stations, and Figure 28 shows the locations of thermoluminescent dosimeters (TLDs) at the RWMC. The monitoring and study data are reported annually as required by the handbook.

5.4.9.4 Soil Moisture Studies. Soil moisture studies were begun in the spring of 1975; these studies investigated readily available chemical sealants and moisture repellants that would eliminate potential seepage of run off water into the TRU waste in Pits 1 and 2, in addition to the physical barrier, e.g., soil. The 1975 investigations indicated that soil cover was effective. In the fall of 1976, Pits 4, 6, and 10 were covered with 40.6 cm of soil, making a total of 9 ha covered in this manner.[111]

A soil moisture and temperature study was begun in January 1977 to investigate moisture movement in the RWMC soil.[112] As part of a long-term study on seasonal moisture movement vertically through surface soils of RWMC, two weighing lysimeters were installed near the RWMC. Information gathered from these devices will (a) contribute to an understanding of moisture movement through RWMC surface soils and (b) assist in predicting rates of radionuclide transport upward through soils overlying pits and trenches in the SDA. This latter information will also be used in surface stabilization studies being conducted at RWMC and will assist improving operations there. Additional information about lysimeters and soil moisture studies at RWMC is included in Reference 118. This study was completed at the end of FY 1982 and the data entered into the environmental computer program.

5.4.9.5 Studies of Radionuclide Uptake. In FY 1978, other studies to investigate radionuclide uptake and movement within the RWMC ecosystem were begun. These studies are being conducted by DOE-RESL personnel, who

TABLE 6. SUMMARY OF RWMC MONITORING

Study	Apparatus/ Collection Method	Frequency	Approximate Number of Samples/Values	Analysis Performed/Results
Wind patterns (DOE, RESL)	Anemometer, wind vane	Continuous	Averaged hourly	Wind rose maps plotted
Temperature (DOE, RESL)	Thermometer, °C	Continuous	Averaged hourly	Values recorded, used in ET[a] studies
Surface runoff	Manual collection 4-L samples	Quarterly	25 to 35 per year	Gross alpha, gross beta, gamma emitters and specific alpha and beta emitters
Stationary air samplers	12 high-volume (0.06 m^3/min) air samplers; 3 (0.06 m^3/min) constant air monitors (CAM)	Continuous	Filters collected every 7 days	Gross alpha, gross beta, and gamma emitters and specific alpha and beta emitters
Soil survey outside RWMC (DOE, RESL)	Manual soil collection at 0 to 5- and 5 to 10-cm *depths*	Once every 7 years (minimum)	103 per period	TRU[c] and major gamma emitters, isopleth maps plotted
RWMC surface soil survey	Manual collection of soil at 0-5 cm depths	Biennual	Minimum of 41	Major gamma emitters, some Pu and Am analysis
Gamma surveys	18 GM[b] tubes suspended from a 6.1-m boom	Biannual	NA[d]	Isopleth maps plotted
Aquifer monitoring (USGS)	H_2O sampled from aquifer wells, H_2O depth of aquifer	Quarterly; H_2O level one a month	16 per year	^3H, ^{90}Sr, specific conductance, Cl^- (quarterly); TRU and gamma emitters (semiannually)
Perched water zone monitoring	H_2O from wells, H_2O level	Semiannual (if possible); H_2O level monthly	Varies; some wells not sampled in *1978*	^3H, ^{90}Sr, specific conductance, Cl^- TRU, gamma emitters
Phase-lag studies (USGS)	Pressure sensors	Continuous	Varies	Degree of permeability

TABLE 6. (continued)

Study	Apparatus/ Collection Method	Frequency	Approximate Number of Samples/Values	Analysis Performed/Results
Soil moisture probes (EG&G)	47 probes	Discontinued	Varies	Soil-temperature, soil-moisture graph
Moisture exclusion testing plots	4 chemical sealants, 1 compacted soil berm, 1 plastic sheet instrumented with 28 soil moisture probes	Discontinued	Varies	Soil temperature and moisture, visual examination of surface for degradation
Mineralogical and geochemical soil parameters	Random soil samples from RWMC	Irregular	NA	pH, CEC[e]; water potential, field capacity
Area monitoring (DOE)	TLD packets	Biannual	46 per year	mrem per period
TSA-1 monitoring	Dewpoint probes, thermocouples	Discontinued	56 per month	Relative humidity, temperature
TSA-2 monitoring	Relative humidity discs, thermocouples, soil moisture, corrosion coupons	Bimonthly	114 per month	Relative humidity, temperature, soil moisture

a. ET = evapotranspiration.

b. GM tube = Geiger-Muller radiation detector.

c. TRU = transuranic isotopes.

d. NA = not applicable.

e. CEC = cation exchange capacity

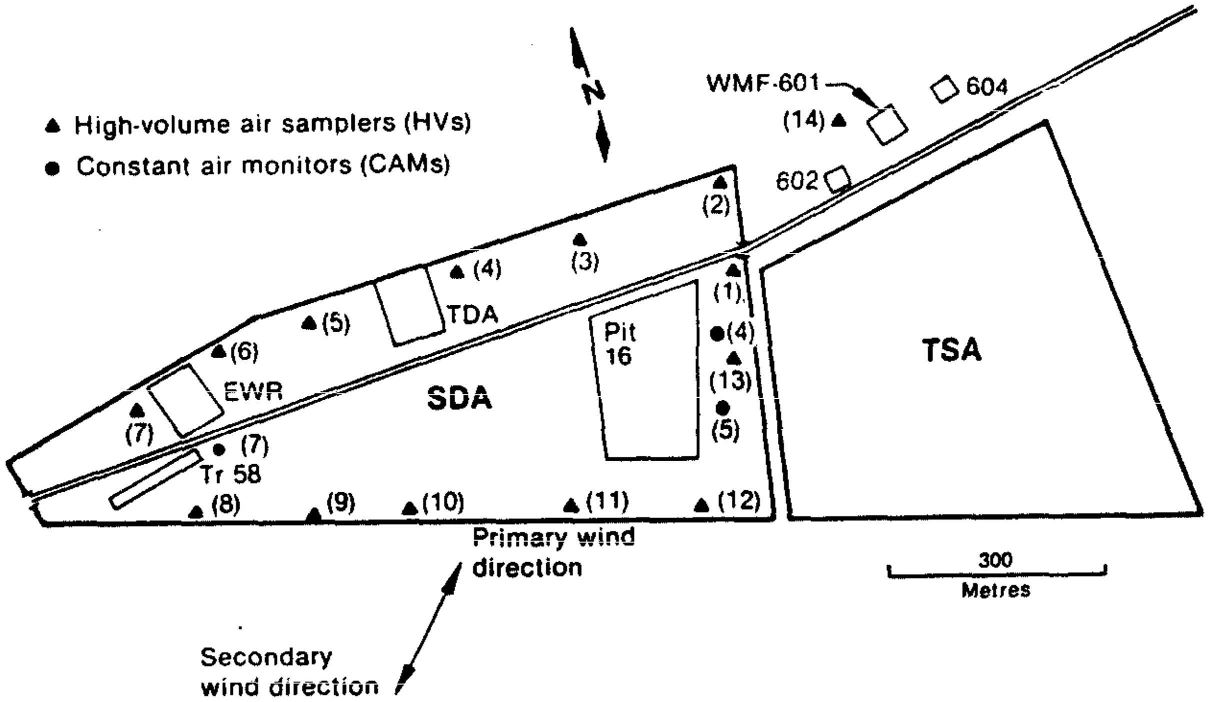

Figure 27. RWMC air-monitoring locations.

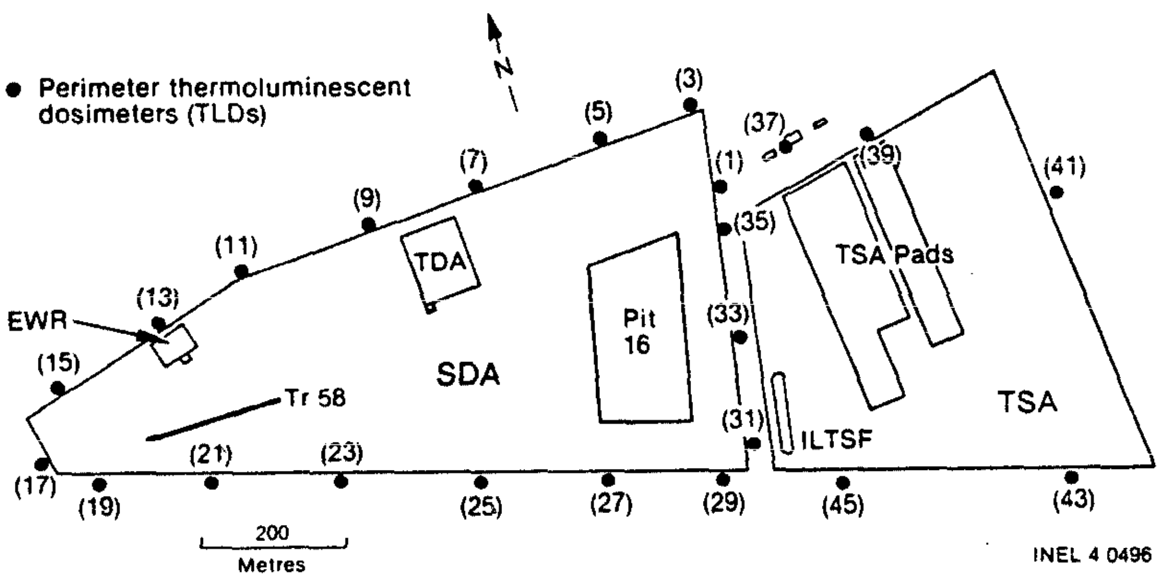

Figure 28. TLD locations.

have performed limited biotic work adjacent to the RWMC in past years. Uptake in both animal and plant species is being studied. Ground squirrel and Russian thistle data are collected in even numbered years; deer mice in odd numbered years. The data are reported in the Annual Environmental Report.

5.4.9.6 TSA Monitoring.[108] A system for monitoring specific environments within TSA cells was initiated in 1974. Dewpoint and temperature measuring probes are placed at various depths in the storage cells and are connected to an electrical, 12-channel recorder. Thus, the relative humidity and condensation conditions within each cell may be monitored. Electro-humidity sensors installed in TSA-2 Cell 1 in 1977, measure relative humidity directly. Data show that relative humidity in that cell averaged 75% throughout the year. In late FY 1979, remote sensors and moisture probes were installed on the TSA-R and TDA; sensors were also attached to drums exposed during retrieval and reentry operations at the TDA.

In February 1978, 34 painted steel, corrosion coupons measuring 5.1 by 7.6 cm were retrieved from various locations in TSA-1 monitoring pipes. These coupons, left in place about three years, were evaluated for corrosion by the Chemistry Research and Development Division of Rockwell International at Rocky Flats. All coupons showed blistering of the painted surfaces, with visible rust appearing on most surfaces and edges. However, since they were placed in the pipes, the coupons were subjected to surface atmospheric conditions unlike those for the drums. An August 1978 inspection of some drums in Cells 1 and 6 of TSA-1 showed the drums to be in good condition with little noticeable rust. The coupon study will be modified to more closely approximate the environments for the drums.

5.4.9.7 Study of Trace Elements and Organics. Earth and Life Sciences Branch sampled fine particulates to determine the extent of atmospheric transport of trace elements and organics from the RWMC. Analyses found nothing out of the ordinary.

5.4.9.8 Study of Uptake and Deposition of Radionuclides in Russian Thistle. Earth and Life Sciences Branch sampled and analyzed Russian thistle growing (a) in subsidence areas over buried waste, (b) over buried waste without subsidence, (c) downwind of, but not over, buried waste, and (d) offsite (control group). The thistle samples were analyzed for uptake and deposition of radionuclides. No abnormal results were reported.

5.4.10 Criticality Control

Criticality control limits have been established for the RWMC transuranic storage and disposal areas. In addition to strict criticality control limits, a fixed percentage of certain categories of waste received from Rocky Flats in drums is analyzed by a computer-controlled drum assayer to verify that the fissile material loading of 200 g per drum is not exceeded. In addition, a statistical sampling of containers is inspected for weight, radiation levels, and contamination levels to verify that the waste-generator-supplied information is correct.